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Analysis and Optimization of an Omnidirectional Direction-Finding System

The purpose of any radio direction-finding system is to obtain information from which the direction of arrival of an electromagnetic wave may be determined. Conventional systems for accomplishing this include null-seeking antennas having directional characteristics that are altered mechanically or electrically, highly directional antennas that can localize a region in space, and antennas composed of elements that use time- and space-phase displacement. These direction finders exhibit one or more of the following disadvantages: (1) they require mechanical positioning; (2) they present relatively large physical structures; and (3) the direction information is redundant or is not in a readily usable form. A direction-finding system which has been investigated analytically and experimentally does not have any of these disadvantages.

The direction of arrival of an electromagnetic wave above a plane earth may be uniquely described in terms of any of several space-coordinate systems. In particular, the knowledge of the direction cosines with respect to two perpendicular axes, both of which lie in the horizontal plane, is necessary and sufficient to describe completely this direction of arrival. Information in the explicit form of direction cosines (or direction cosine analogs) is highly desirable in many applications. By means of simple analog circuitry, the information may be converted into that relating to other coordinate systems.

Although direction cosines appear as phase factors on the terminal voltages in linear arrays, there is difficulty in actually determining these direction cosines by phase measurement, because of the unavoidable mutual impedances among the elements making up the array. By choosing an array with the proper spatial symmetry, and by the use of signal-processing equipment, the undesirable mutual impedance effects may be eliminated from the system. Essentially omnidirectional antenna elements are required to observe the hemisphere above a plane earth.

Certain components and characteristics of a theoretical system were analyzed and optimized, and the results were used to devise an experimental system capable of providing accurate direction information.

Note:

Requests for further information may be directed to:

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No patent action is contemplated by NASA.

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